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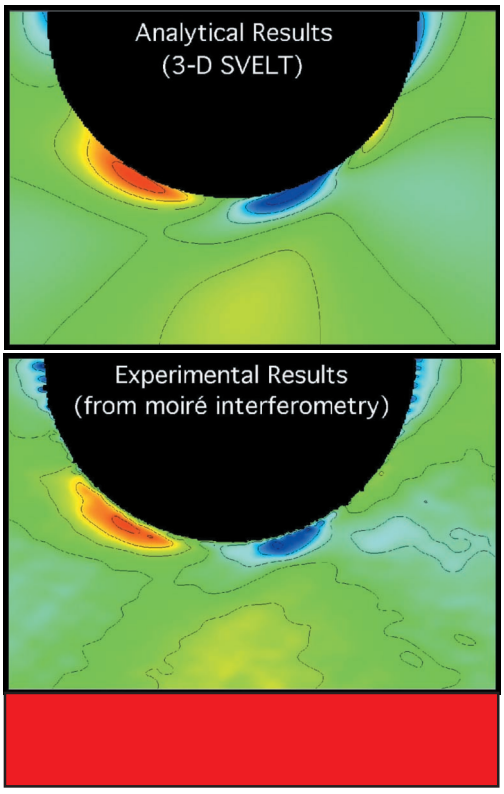
Science and Technology for Tomorrow's Aerospace Forces

Success Story

ADVANCES IN BOLTED COMPOSITE JOINT STRENGTH PREDICTION IMPROVE STRUCTURAL INTEGRITY OF MILITARY AND COMMERCIAL AIRCRAFT



A Materials and Manufacturing Directorate's cooperative effort yielded significant breakthroughs in mechanical modeling that provide greater insight into the strength of bolted composite structures, while reducing cost and risk on future programs. This effort also demonstrated the formation of unique partnerships between government and industry to achieve solutions to complex problems.

Air Force Research Laboratory
Wright-Patterson AFB OH

Accomplishment

Materials research scientists at Wright-Patterson AFB, Ohio, in cooperation with industry, continue to make dramatic advancements in mechanical modeling to predict the strength of bolted composite joints that are critical to safe and cost-effective flight operations. The ability to predict the strength and evolution of composite materials damage, such as cracking and delamination, particularly at microscopic levels profoundly impacts the design of future composite structures, while trimming millions of dollars off life-cycle costs.

Background

In the past, industry used several different methods to model the strength of bolted composite joints, including two-dimensional, semi-empirical models that assumed a fixed contact zone between the bolt and the composite material. Industry methods predicted strengths that varied considerably from statistically measured joint test configurations. Due to the difficulty in conducting combined loading tests, comparing test results to predictions of simulated structures subjected to multiaxial loading and shear was not possible.

Directorate researchers developed a new, advanced method based on accurate three-dimensional stress analysis called Spline Variational Elastic Laminate Technology (SVELT). In-house efforts experimentally validated the new analysis method, focusing on initial ply failure and surface strain behavior around the hole. Qualitative agreement between SVELT predictions and actual initial failure locations, and the excellent quantitative experimental and analytical strain behavior indicated that SVELT was accurately predicting ply-level behavior. Further experimental investigations verified the accuracy of ply-level predictions of stress and strain and justified additional investigation.

SVELT refinements and modifications include the provision of an elastically deformable bolt. This technology can also examine where a pure interference fit exists between the bolt and the hole. The Air Force and industrial participants signed a formal partnership ensuring the availability of industrial participation to help guide future SVELT development efforts.

Materials and Manufacturing
Emerging Technologies

Additional information

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